XII. *On stridulation in ants.* By Dr. David Sharp, M.A., F.R.S., F.L.S., &c.

[Read March 8th, 1893.]

Plate IX.

The question whether ants possess definite organs for the production of sound has been discussed by Landois, Lubbock, and one or two others, but no very extensive or decisive evidence has yet been brought forward on the subject. My object in this paper is to point out that many kinds of ants possess very perfect special stridulating organs, and that these are not only of very great delicacy, but are accompanied with such perfect articulations as to render it probable that the insects by their aid can produce a considerable variety of sounds, and have in all probability much power of modulating these.

Landois, in a scarce book called 'Thierstimmen,' announced, in a few words in 1874, that an ant he called *Ponera quadridentata* possesses a true stridulating organ, and he added that this is also the case with *Lasius fuliginosus;* shortly afterwards Lubbock, alluding to Landois' discovery, sketched a structure in *Lasius flavus* that he thought might possibly be connected with production of sound. About the same time Swinton mentioned that he had heard sound produced by *Mrymica ruginodis*, and gave a rough sketch of what he thought was the organ for its production. These cases are all that I know of, except a brief allusion by Prof. Forel to a structure in a Madagascar Ponerid, *Leptogenys falcigera*, which, he remarks, may possibly be an organ of stridulation.

The structure first alluded to by Landois in *Ponera quadridentata* is doubtless a true stridulating organ; but what he described in *Lasius fuliginosus*, and what Lubbock sketched in *Lasius flavus*, are not stridulating organs, but are merely the sculpture that exists on articulating abdominal surfaces in ants generally. Al-

though these surfaces are not stridulating organs, I think it quite possible they may be used by friction for producing rustling sounds of considerable variety, though at present there is no evidence to that effect. The figure given by Swinton is altogether erroneous; he in part indicates the spot where the stridulating organ in *Myrmica* is really situated, but, instead of figuring the sculpture that is actually there, he has delineated a striation that does not exist; he has, in fact, transferred the general sculpture to the spot from which it is in reality absent, being replaced by the stridulating surface. Swinton's figure was reproduced by MacCook, and thus obtained a currency which is to be regretted, as it may probably have misled observers. He was no doubt in part deceived by insufficient glasses, for the stridulating surface in *Myrmica* is so beautifully formed and so delicate that it appears smooth and polished until a high power and a proper light are applied so as to resolve the lines.

Entomologists who have discussed this subject have mostly stated that no purposeful sounds audible to human ears are produced by ants, though some cases have been recorded in which sound was produced by the ants striking their heads in concert on a foreign substance, such as a dry leaf. It is no doubt true that the stridulation of most of the species of ants that occur in Europe cannot be directly detected by the human ear, but this is not by any means true for all ants. Mr. R. C. Wroughton, who has within the last few weeks published an excellent paper on the ants of India, discusses Lubbock's statement that ants produce no sounds that are audible to us; saying, "I am almost certain, however, that I have heard such sounds. When one of the large brown paper nests of *Cremastogaster rogenhoferi* is violently and suddenly disturbed, the ants swarm out in thousands, wagging their abdomens in the manner so characteristic of *Cremastogaster* when excited; at such times a distinct hissing sound is audible, as if a red-hot cinder had been plunged into water. I had always accounted for this by supposing it was caused by the material of the nest under the feet of the ants, and a similar though fainter sound, which may be heard when a large nest of *Camponotus* or *Polyrhacis spinigera* is disturbed, by the rubbing together of the bodies of the

ants, who are all in violent movement at once. The passage from Lubbock, quoted above, however, leads me to think that this is not so, but that the audible noise is the sum of the individual stridulations of countless ants. The tail-wagging of *Cremastogaster* would account for the sound made by them being louder, though they are so much smaller than *Camponotus* or *Polyrhacis*.* I had asked Mr. Aitken to make some experiments to check the results I thought I had obtained. Members will no doubt recognise his hand in the following characteristic note, which fully supports my contention:—'I do not need to experiment. The roar raised by a squadron of *Lobopelta*, if you poke at them with a straw, does not require to be listened for with your hand to your ear. I should like, however, to know something about the organs by which it is produced. Military drums, I should think.'"

The evidence of two such good naturalists as Messrs. Wroughton and Aitken is very valuable, and I am glad to be able to bring forward a more direct and conclusive demonstration, by describing and figuring the organs, and by saying that I have been able to make them work so as to produce audible results. By operating with the stridulating organs of several species of *Atta*, a quite audible sound is produced. A very distinct sound is also heard when the appropriate movements are made with *Dinoponera grandis* and *Pallothyreus communatus*, and I have also been able to hear an extremely faint sound by working with the abdomen of a species of *Pseudomyrma*.

I will now give descriptions of the stridulating organs in several species of ants selected from various divisions of the family, and will conclude with a summary dealing with some of the points of particular interest.

The stridulating organ consists of a series of delicate lines placed on the middle of the base of the dorsum in the 3rd abdominal segment, and in addition to this of a special development of the posterior edge of the previous segment. Between these two parts there is a co-adaptation.

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* *Camponotus* and *Polyrhacis* do not stridulate; they belong to the subfamily Camponotides, in which group there are no stridulating organs.—D. S.

Although these structures do not exist in the Camponotides, it will be convenient to give a description of the condition of the corresponding spots in this group.

Before passing to the descriptions, I should like to express my thanks to Mr. Salvin for supplying me with some specimens from Guatemala; to Mr. Champion for others collected by Mr. J. J. Walker in Australia and Tasmania; and to Prof. Forel, of Zurich, for supplying me with the names of some of the species alluded to.

Camponotides.—*Camponotus cruentatus* (worker major). Pyrenees. The sculpture on the retracted and covered parts of the segment is quite free from setæ, and becomes coarser and more distant as the base is approached; it is, in fact, similar in nature to the sculpture in the Ponerides, with the exception of the absence of the stridulating band, and with this great difference, that the sculpture of the exposed portion passes gradually into that of the covered portion, whereas in Ponerides there is an abrupt line of demarcation between the two.

Camponotides.—*Lasius flavus* (worker). A very short space or ring extending all along the base of the segment is covered with rather coarse irregular lines. The line of demarcation between this and the general surface of the dorsal plate is abrupt, and there is an extreme difference of texture between the space uncovered and that covered by the overlapping part of the preceding segment.

L. fuliginosus (worker). England. As in *Camponotus* and *L. flavus*, there is no stridulating organ; the ring of sculpture at the base of the segment is finer than it is in *L. flavus*, and the line of demarcation between the general sculpture and that of the basal ring is not so abrupt.

Ponerides.—*Dinoponera grandis* (worker). Amazons The retractile portion of the third segment is covered with a beautiful sculpture of transverse slightly irregular and broken up lines, very densely packed; in the middle of the dorsum there is a narrow band of finer, longer, and perfectly parallel lines. The edges of this band are extremely irregular in outline; this arises from the fact that the stridulating lines have a reflecting power different to that of the contiguous sculpture, and these two textures pass into one another irregularly. In some places the lateral lines are prolonged into the stridulating

band, in other places the lines of the stridulating band project into those of the neighbouring sculpture. These conditions show conclusively that the stridulating band is formed out of the general sculpture of the segment by this becoming more regular, finer, and denser. In the two individuals examined there is considerable difference in the outlines of the band, and in one the striæ and sculpture seem to be finer than in the other. The hind margin of the preceding segment is delicate, and is slightly crenulated so as to be irregular in outline; but the crenulations are absent from the part which lies over the file of straight lines, so as to make this part perfectly regular, and to correspond exactly with the file. Pl. IX., figs. 1 & 2.

Ponerides.—*Paltothyreus commutatus*, Rog. Amazons. In the middle of the dorsum of the retracted part of the third abdominal segment there is a longitudinal band of fine, perfectly parallel, lines; these lines extend over the greater part of the length of the retractile portion of the segment; the sculpture of the adjacent parts consists of coarser, more distant, and less regular lines, which are broken up into comparatively short pieces.

Ponerides. — *Ponera contracta* (worker). England. The sculpture of the retracted portion of the segment is in this species remarkably coarse and distant, while in the middle there is a band of extremely fine lines, so different from the rest of the sculpture that it would not be believed to be a modification thereof. In this species the band is more "differentiated" than in any other Ponerid I have observed; by this I mean that there is a greater and more abruptly limited difference between it and the adjacent parts. Fig. 3.

Ponerides. — *Ponera* ? sp. (worker). Hobart. Very rough sculpture: worker. The apical part of the retractile portion of the segment consists of lines of deep rather coarse sculpture, which are but very little broken up or irregular; nearer to the base the segment is very much more densely and finely striate; in the middle of the dorsal region these striæ leave a broad space, which appear highly polished and smooth, but which, on examination with a high power, can be seen to be very densely covered with perfectly regular, densely-packed, lines.

Independently of the extremely fine striation this species is remarkably different from *Dinoponera*, on

account of the broad space over which the lines extend; the limiting line between the retractile and the other part of the segment is also peculiar, consisting of a ring of deep depression. The scraping ridge on the hind margin of the post-nodular segment is also remarkable, being very fine and definite, and standing out in very evident contrast to the rugosities contiguous. Altogether this is a very remarkable apparatus. The structures are in several respects similar to what exist in the *Myrmicides*, the shape of the band, its glossy surface, and the structure of the scraping organ being all Myrmicid. Fig. 4.

Ponerides.—*Diacamma vagans*, Sm., ♀. Hong Kong. The retractile part of the second post-nodular segment is evenly covered with a dense, fine, reticulate structure, without any trace of a differentiated surface for stridulating. The hind margin of the preceding segment can hardly be considered to form a scraper, as it is scarcely more than a slightly projecting membranous edge that is somewhat minutely crenulate.

As a sound producer, this is probably the most inferior Ponerid I have seen.

Ponerides?.—*Cerapachys* (*Eusphinctus*), n. sp. (worker, quite blind). Baudin Island. The retractile portion of the second post-nodular segment is covered with a coarse sculpture similar to that of *Ponera contracta*, but there is no trace of any stridulating band; neither is there any differentiated stridulating edge or scraper on the preceding segment.

This is a most peculiarly formed ant, the abdomen being of very unusual construction, each abdominal segment being so formed that the limits so far as which it may be drawn into the preceding are exactly defined. If it possess a sound-making power, this probably exists on several of the segments, each of which has its hind margin turned directly downwards, and tightly grasping the retractile portion of the following segment, so that when all the segments are drawn rapidly backwards and forwards together or successively, a sound of a grating character may possibly be produced.

I look on this as a very peculiar and yet very little evoluted form of ant. I have had a brief communication made to me about it by Prof. Forel, from which I judge this to be an ant the peculiarities of whose external

structure are greatly in need of elucidation. I have great doubts whether it ought to be placed in the Ponerides.

Ponerides ?. — *Myrmecia*, sp. ?. The second post-nodular segment has a broad neck, which is perfectly cylindrical; this neck is completely different in sculpture from the rest of the segment (and also usually in colour, resembling in this latter respect the previous segment by which it is covered). The sculpture is a beautifully developed system of transverse lines; they are everywhere the same on all parts of the neck, except that on the ventral surface they are a little coarser and less regular. The hind margin of the post-nodular segment has so minute a scraping edge that it can only be satisfactorily detected by separating the segment.

I have examined several species of this most interesting genus of ants—the "bull-dog ants" of Australia; they are all similar, with some slight distinctions in the sculpture. The condition is not that of a differentiated stridulating organ, as the lines are not perfectly regular, and cover the whole surface. Nevertheless, I think it probable that the parts may act as a sound-producing organ, by, after the manner of the Ponerides, retracting and extending the segment; the very fine minute scraping edge striking against some of the lines here and there notwithstanding their slight irregularities.

Ponerides. — *Amblyopone obscura* (worker). The retractile portion of the post-nodular second segment is very sharply defined, and is covered with a system of symmetrical sculpture, which, though it extends chiefly in the transverse direction, does not form straight lines. The scraper on the hind margin of the preceding segment exists, and its hind margin possesses apparently some excessively minute crenulations.

Although there is no definite stridulating organ in this insect, I should think the parts act as if there were one, and with the result of producing a sound of a much less perfect character. The female is like the worker in these respects. This is an insect of extreme insect. During an examination I have lately made of the external skeleton in ants, I came to the conclusion that this was the most primitive of the existing ants known to me, and also that it should form a separate subfamily on account of the imperfect differentiation of the node. On communicating my view to Prof. Forel, he informs me that

he has already come to a similar conclusion himself, and has recently made some remarks on the subject in the 'Transactions' of the Society of Naturalists at Bremen.

Perhaps I may be excused for calling attention to the interest that would attend the certain identification of the male of the insects of this genus.

Odontomachides.—*Odontomachus ruficeps*, Sm. (worker). Australia. The retractile portion of the second post-nodular segment is elongate, being quite equal in length to the exposed portion; it is covered with a dense very fine transverse sculpture of only a partially rectilinear character, but in the middle of the front portion of the retractile part there is a band, or rather a cone, of excessively fine perfectly regular lines. The scraping edge of the preceding segment is in this species provided with a peculiar structure, the sharp edge just over the band being a little more turned downwards, so that it rakes more vertically over the lines; besides this the hind margin just in front of the band is thickened, and deviates minutely from a straight line; perhaps this is correlative with the turning down of the edge attached to it.

Odontomachides.—*Anochetus ghiliani* (worker). Gibraltar. The retractile portion of the second post-nodular segment is covered with a coarse somewhat irregular sculpture (like that of *Ponera contracta*), and there is no stridulating band.

The great difference in abdominal structure between this and the *Odontomachus ruficeps* is remarkable in the case of two genera considered to be so closely allied. *Anochetus ghiliani* has the retractile portion of the second post-nodular segment not half so long as the exposed portion, and the two parts are separated by a well-marked constriction of the true *Ponera* kind, this division being absent in the *Odontomachus*.

Myrmicides.—*Myrmica scabrinodis* (worker). England. The base, or neck, of the segment behind the second node is quite short, and is at the sides covered with sharply raised, quite irregular, rather short, transverse lines; in the middle there is a broad space appearing perfectly smooth and polished, but which, under a high power, proves to be very regularly covered with straight, very fine ridges. The perfect regularity of these fine lines is highly remarkable. The edge, on the hind

margin of the second node, by which these lines are scraped is excessively thin.

Myrmicides. — *Aphænogaster barbara* (worker). E. Pyrenees. The neck formed by the base of the segment behind the second node is short, but it is prolonged forwards somewhat in the middle of the dorsal region, so as to be longer there. The whole of the median part is covered by excessively fine lines, very densely packed, uninterrupted, and quite straight. The surface at the sides of the neck has a very minute, dense, quite different sculpture.

Female.—Malta. The surface covered by the fine lines is very much less, and the lines are many of them largely interrupted, as might happen when a diamond making a very fine scratch on glass missed its hold of he glass now and again.

Myrmicides. — *Sima*, sp. Fremantle, W. Australia. The neck of the segment is rather long, and there is a stridulating band on the middle; the striæ on the front part are coarser than the neighbouring sculpture, and on the apical part are much finer; there is an abrupt line of demarcation between the coarse and fine lines.

This species is unique amongst those I have examined in having the stridulating band divided into two parts, one consisting of coarse, the other of fine, lines; a stridulating performance by this insect might produce very extraordinary effects. The fact that the basal lines are coarser than the neighbouring sculpture is without any parallel in the other ants I have examined, and appears to indicate that the division of the stridulating band into two parts is of importance. Possibly a sound from this insect might begin as a sort of roar, and in the middle of its utterance suddenly change to a sort of squeak; on the other hand, by using at one time the anterior part, at another the posterior part of the file, two different and even abruptly contrasted sets of sounds might be produced. Fig. 5.

Sima rufo-nigra (worker).—East India. The sculpture of the neck of the first segment behind the second node is rather coarse, and in the middle of the dorsal region it becomes striæ; these are not, however, very regular, and on the front part of the neck are coarse, while on the apical part they become finer and more regular; this is in opposition to the neighbouring sculpture, which

is a little coarser on the apical than it is on the basal part. The female differs but little from the worker.

Myrmicides.—*Pseudomyrma*, sp. (worker). Guatemala. The lines in this species are excessively fine, but the structure in other respects appears similar to *Sima rufonigra*. In working with a specimen of this species taken from spirit, I detected an excessively minute sound when the appropriate movements were made.

Myrmicides.—Gen. ?, sp. (female). Amazons. The segment behind the second node forms on the dorsal aspect a well-marked scutellum; its surface is very peculiar, the outer layer of the integument being colourless and transparent, so that the structure and colour of the inner layer are seen through the outer one, and render the external condition of this latter very difficult to distinguish. It appears, however, that at the sides there is a rough irregular but very fine sculpture, and in the middle a broad oval space, which is very finely and regularly striate. I think the lines in this insect are finer and closer than in almost any other; the length of the exposed part of the scutellum is about five-eighths of a millimetre, and, as a rough estimate, I should say there are nearly 200 lines on it, which would be at the scale of 7000 or 8000 to the inch. Fig. 6.

The perfect transparency of the stridulating surface in this species is very remarkable; the inferior layer of the derm can be seen through the outer, even at the sides of the neck, but the outer surface, on which the lines are situated, is quite transparent, and the layer beneath seems to be of cellular structure. The conditions seem to indicate that this part of the skeleton may be more resonant or give a purer note than ordinary chitine would.

Myrmicides.—*Atta cephalotes* (worker major). Amazon Valley. (Undissected specimen). The portion that can be exposed of the neck of the segment following the second node is not extensive, and is quite dull, owing to being covered with densely placed transverse but somewhat irregular and interrupted lines; along the middle there is a slightly raised space, and this is covered with quite regular, much coarser, and more sharply elevated lines; the surface of the neck of the segment is very strongly curved, the convexity being in two directions, as in a convex lens.

Worker minor. — Amazon Valley. Similar to the major, with the exception that the sculpture is much finer, and the lines of the stridulating band less elevated.

Winged female. — Demerara. (Dissected specimen). The neck of the segment is very short—indeed, it scarcely exists except in the dorsal region; in this latter part the sculpture on it is very fine and dense, and on the middle there is a band of stridulating lines, which are finer than in the worker. The scraping band on the hind margin of the second node is very prominent all across the dorsum of the segment. The size of this individual is enormous in comparison with the workers, and yet the stridulating lines are finer.

Male.—Demerara. (Dissected specimen). The neck of the segment is almost absent, even the dorsal region scarcely prolonged enough to form a scutellum. The sculpture on the surface of the dorsal region is very fine and densely sculptured, and on the middle forms densely placed and regular fine lines of considerable length in the transverse direction; the surface on which the lines are placed is slightly convex in the transverse direction. The second segment of the node is provided behind with a ridge, that is comparatively little prominent at the sides, but is very much so in the middle, and is curvate so as to correspond with the slight convexity of the surface on which the stridulating lines are placed.

Atta, sp. ?.—Guatemala. I have experimented with a number of specimens in spirit entrusted to me by Mr. O. Salvin, and I find that the various forms of workers produce quite audible sounds; there are, however, some individuals which I have failed with; my repeated efforts to produce sound by causing the parts to execute the appropriate movements having been quite unsuccessful. A female stridulates more loudly than any ant I have examined. Fig. 7.

In the case of this interesting genus of ants—the leaf-cutting ants of books of travel—I have found more audible sounds produced than in any other ant. The function of the worker majors of these creatures has been a mystery, Bates having quite failed to detect any use for them. The fact that they are endowed with sound-producing organs renders it possible that they may be individuals whose deficiencies in other respects may make them more sensitive in the matter of sounds.

But this is, of course, a mere suggestion, and still leaves it doubtful what the use of the enormous heads of these individuals can be. Before attempting to answer that question dissections should be made to see what is the condition of the nerve centres in the head, as this might prove instructive.

Myrmicides.—*Cryptocerus atratus* (worker). Amazons. In this insect the neck of the post-nodular segment is short and not prolonged in the middle; the whole of the upper surface of the neck is densely and finely sculptured with a short transversely linear sculpture, without any stridulating lines on it. There is no scraping ridge on the hind margin of the node.

In this insect there is apparently no means for producing sound by the action of these parts.

Ecitonini.—I have examined workers of several species of *Eciton*, and find that they have no stridulating organ, the sculpture being uniform all over the dorsum of the neck of the segment.

The organs of stridulation consist of a file, *i.e.*, a series of perfectly regular, straight lines placed on the middle of the dorsal region of the third abdominal segment, and of a scraping instrument placed on the hind margin of the preceding segment. The file is slightly raised, and a little curved transversely.

These organs appear to be absent in the Camponotides and Dolichoderides; in the Ponerides and Myrmicides they are usually present, but are sometimes absent, and I think it probable that one group of Myrmicides (Cryptocerini) will be found to be quite destitute in this respect.

The file or stridulating bands appears, in the case of the Ponerides, to be a development from the sculpture of the parts. The condition of this band, as seen in *Dinoponera grandis* and in *Paltothyreus* (?) *commutatus*, shows that the sculpture has only to become on some spot more regular and denser, and the surface slightly raised to transform the general sculpture into a rudimentary stridulating band. A tension acting transversely on the spot, supposing the materials not to be absolutely rigid, might be, I should think, capable of effecting the transformation. The scraping ridge is merely a development of the chitinous membrane by which the second segment is bordered behind; this

becomes more rigid and prominent, and at the spot where it is placed over the band, more perfectly regular, and so forms a sharper and truer edge.

The stridulation in Ponerides is performed by drawing out the third segment, and at the same time slightly depressing the hind part of the second segment so that the edge of this scrapes over the band; the beautiful articulations of the node allow this latter part of the operation to be performed with the utmost delicacy, and permit the touch of the scraper on the band to be greatly raised. In the Myrmicides the operation appears to be carried on in a different manner. The scraper is more developed, and is placed on the hind margin of the second node; this apparently is held rigid, and the upper surface of the following segment is thrown against it, so as to bring the band into contact with the scraper; a very slight vibration of the hind body will then bring about some stridulation.

It is by no means clear that in the Myrmicides the stridulating band is merely a development from the general sculpture; it is in some cases excessively different from this, and the striation has the appearance of being developed on a glassy surface poured out on the ordinary surface. The scraping ridge is not a direct continuation of the hind margin of the segment, but is placed on a lower plane. There is, however, one Ponerid known to me, fig. 4 (Tasmania), in which these parts are in an intermediate condition. Either that is a Ponerid in which this organ has been formed as in the Myrmicids, or it is a greater development of the Ponerid structure in the direction of the Myrmicids.

There is great diversity between the different species; this may possibly produce results as great (comparing small things with large) as that between the voices and song of different species of birds. There is evidently considerable difference between the sexes and castes of the same species, and I think also between individuals of the same caste, but this I have not properly tested; and it will, indeed, probably be found to be very difficult to judge of the value of minute differences of structure as producing diversity in the vibrations; if, however, I have correctly interpreted the phenomena I have observed in *Atta cephalotes*, I must conclude that small structural differences may be accompanied by great distinctions in

results ; and this independently of any differences in the muscular apparatus, which may be considerable or not, this point not having been at all examined.

It is impossible to examine a series of these structures, to note their peculiarities and the perfection that is attained in some of them, without concluding that they must be of considerable importance in the organisation of the creature. Whether they form a definite means of communication I cannot even guess, though I can quite see that investigation might probably prove them to be capable of producing a considerable variety of sounds in the case of one of the higher species.

It is true, as I have already stated, that these organs of stridulation do not exist in the great division Formicides of the older authors (the Camponotides and Dolichoderides of Forel) ; but nevertheless it appears quite possible that the same parts in those insects may be able to produce a considerable variety of sounds of a rustling nature by rubbing together, with a variety of movement, the sculptured surfaces of two overlapping parts, or by dragging a semimembranous border over a wrinkled surface ; and the examination of *Camponotus cruentatus* seems to increase the probability of this supposition.

The striation of the file in ants is similar to what it is in such Coleoptera as the Longicornia and Ipsini, though it is finer and more delicate in the ants. In this latter group the delicacy of movement given to the parts of the stridulating apparatus by the perfection of the joints at the nodes greatly increase the probability that a considerable variety in the sound may be produced. The fact that in *Sima*, sp. the band is divided abruptly into two very different parts strongly supports the idea that variety in the sound is of importance, as well as the mere making of a noise.

Perhaps I may be allowed to remark in concluding that I consider organs of hearing in insects and the sounds produced by the creatures to be a more promising field of research than the organs of sight, owing to its greater simplicity. If we could invent some means of hearing the sounds produced by ants, it might do much towards solving the question of their means of communication and recognition. I may, too, say a word of caution against the supposition that "hearing" in ants

means the same thing as "hearing" in man. The organs of the higher senses in insects are so profoundly different from those of man, and the nerve communications and centres are so fundamentally distinct, that a particular sound to an insect may be a totally different thing to what it is to us; hence, though it is known that ants are deaf to many sounds we hear, it is none the less probable that they may hear where we are deaf. Very little is at present known as to the organs of hearing in insects other than Orthoptera, and when they are known we may be sure that there will still be great difficulty for us in realising what an insect really hears. Still, I think the difficulties will not be so great as they are in the case of the ocular organs and sense of sight.

Explanation of Plate IX.

Fig. 1. Portion of the dorsum of the articulating neck of third abdominal segment of *Dinoponera grandis* (worker), showing the stridulating file and contiguous sculpture.

Fig. 2. Hind margin of second abdominal segment of *Dinoponera grandis*, showing the margin crenulated, except at *a*, which passes over and scrapes the file.

Fig. 3. Dorsal surface of articulating neck of third abdominal segment of *Ponera contracta*, showing the articulating file and contiguous sculpture.

Fig. 4. Stridulating organ of Ponerid from Tasmania, showing the file on third segment, and the edge (displaced) *a*, of the second segment that scrapes the file (worker).

Fig. 5. File of *Sima ?*, from Australia (worker).

Fig. 6. File of Myrmicid, from Amazons Valley (♀).

Fig. 7. File of *Atta*, sp., from Guatemala (worker).